THE DEVELOPMENT OF THE GEORGIA AUTOMATED ENVIRONMENTAL MONITORING NETWORK

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REFERENCE: *Proceedings of the 1991 Georgia Water Resources Conference*, held March 19 and 20, 1991, at The University of Georgia. Kathryn J. Hatcher, Editor, Institute of Natural Resources, The University of Georgia, Athens, Georgia, 1991.

INTRODUCTION

Weather is one of the most important factors which controls crop growth, development, and yield. The 1990 drought in southern Georgia, for instance, caused a significant reduction in agricultural production, especially for non-irrigated cropping systems. Continuous monitoring of weather conditions is, therefore, needed to develop a climatic data base which can be used for agricultural, ecological, optimum management of water resources, and other environmental research (Hubbard et al., 1983; Tanner, 1990). This paper will describe the history behind the development of an automated weather station network for Georgia and the current status and operation of this network.

GENERAL OVERVIEW

Presently no statewide weather station network exists in Georgia which monitors weather and other environmental variables on a continuous basis. Although the National Weather Service (NWS) has established a network of cooperative stations, this information is insufficient for agricultural applications. These stations record only daily maximum and minimum air temperature and precipitation. At the same time these data are not available on an instantaneous and continuous basis. Other small networks of either rain gauges or temperature sensors exist as well, but data are either not quality controlled or are not accessible to scientists or the general public.

Successful Automated Weather Data Networks (AWDN) currently exist in Arizona, California, Florida, Illinois, Louisiana, Nebraska, North Carolina, Ohio, Texas, and other states (Brown, 1987; Chang et al., 1983; Curry et al., 1988; Dugas and Heuer, 1985; Hubbard and Hines, 1990). In the Fall of 1990 a proposal was approved in Oklahoma to establish a statewide AWDN, with at least one automated weather station sited in each county (Oklahoma Climatological Survey, 1990). The network in Nebraska, which actually also covers neighboring states such as Kansas, Iowa, Wyoming, and South Dakota, and the proposed network in Oklahoma are the most extensive ones with more than 80 automated weather station in each network.

Activities in Georgia

An interdisciplinary committee, existing of representatives of the University of Georgia (UGA) Agricultural Experiment Station, the UGA Agricultural Extension Service, USDA-Agricultural Research Service, and NWS, was formed in 1987 to study the need for a UGA Automated Weather Station Network. In the final report of this committee it was concluded that continuous long-term weather records are needed for many areas of the state and also that real time data are needed for applications in agriculture and research management (Westbrook et al., 1988). Other high priority items included standardization of data collection and quality control of collected weather data.

In January 1990 an AWDN workshop was organized by the Division of Agricultural Engineering to determine the need for a Georgia AWDN; to identify potential users and supporters of a Georgia AWDN; and to identify the characteristics of a Georgia AWDN. This workshop was cosponsored by the USDA/ARS, the UGA Agricultural Experiment Station, and the UGA Agricultural Extension Service. More than 40 people participated in this meeting, representing 32 federal, state, public, and private agencies and organizations. It was recommend to the Directors of the Experiment Station, Extension Service, and USDA/ARS, to immediately start with the development of a pilot AWDN for Georgia. The College of Agriculture would assume leadership and a faculty member would be responsible for the initial organization of the network. Once this pilot network has established credibility, which will include adequate maintenance of the sensors and quality control of the measured data, there is the potential to include other stations, other sites, and new and additional sensors. It was also proposed to change the name from AWDN to Georgia Automated Environmental Monitoring Network (AEMN) to more accurately represent the information which can potentially be monitored by the system.

CURRENT STATUS

Hardware

Due to budgetary constraints, the development of the Georgia AEMN has been slower than was originally expected. Automated weather stations for two locations have been purchased, while a third AWS is currently on order. These three AWS will be located in Griffin, Midville, and Tifton. The stations will initially monitor air temperature; soil temperature at three different depths; relative humidity; solar radiation; precipitation; wind speed; and wind direction (Table 1). Data will be measured at one-minute or smaller intervals as needed. Optional sensors for open pan evaporation and photosynthetic active radiation will be added at some of the sites. In addition sensors can be attached to measure soil moisture, barometric pressure, dewpoint, UV-B radiation, ozone concentrations, and other environmental variables.

TABLE 1. Initial Sensor Specifications for the Georgia Automated Environmental Monitoring Network.

Parameter	Sensor	Manufacturer
	Standard	
Air Temperature	Humidity-Temperature Probe	Rotronic
Soil Temperature	Temperature Burial Probe	Campbell
Relative Humidity	Humidity-Temperature Probe	Rotronic
Precipitation	Tipping Bucket Rain Gage	Texas Instruments
Solar Radiation	Pyranometer Sensor	Li-Cor
Wind Speed	Wind Speed Sensor	Met One
Wind Direction	Wind Direction Sensor	Met One
	Optional	
Pan Evaporation	Evaporation Gage	Qualimetrics
Photosynthetic Active Radiation	Quantum Sensor	Li-Cor

The base unit of the system is a Campbell Scientific CR-10 data logger, with rechargeable batteries and a solar panel. A modem is used for communication, downloading of data, and other information exchange. The system is programmed to monitor all sensors at specific time intervals. Summaries are stored at one-minute, hourly, and daily intervals. These include either averages, maxima and minima, totals, or standard deviations.

Communications

A centrally located personal computer in the Department of Agricultural Engineering at the University of Georgia in Griffin polls all stations at midnight. The computer calls each station individually and downloads the data which have been collected during the previous 24 hours. Following the downloading procedures for all stations, the records are verified by a quality control program to check for possible errors in the data and potential problems with the sensors. Flags are set to warn the operator if data are missing, if values of the data are out of range, or if there is any other problem with the data. Finally the error-checked data are stored in a permanent database.

Users

The computer programs and software developed by the High Plains Climate Center (Hubbard and Hines, 1990) are being adapted to fit the needs for the Georgia AEMN. This includes both software for communication with the weather stations; downloading of the data; quality control; data storage; and several application programs. So far no procedures have been established for dissemination of the weather data. The Southeast Agricultural Weather Service Center of the NWS in Auburn, Alabama, has shown an interest in storing the data in their bulletin board computer system. It is expected that the National Climate Data Center of the NWS in Ashville, North Carolina, will also be adding the data to their system. There might be a possibility that some of the traditional NWS cooperative weather stations on the UGA experiment stations will be terminated once the AWS have been installed and are fully operational.

Uses

Based on the discussions of the AWDN workshop, there is a strong interest among federal, state, local, public, and private agencies and organizations in weather and environmental data. Possible applications in agriculture include irrigation scheduling and pest management. Especially the linkage of crop simulation models with weather data has capabilities to improve both the quality and quantity of agricultural production. The availability of high quality weather data has also potential for improving efficiency in both generation and use of energy. Potential applications for weather data also exist in water management and other hydrological areas. Finally the type of detailed data which will be collected can be used for historical archival and climatological analysis. Especially with the current concerns about Global Climate Change, good-quality long-term weather data are needed.

Initially the number of sites covered in the pilot study of Georgia AEMN will be small (Table 2). Depending on the availability of funds, it is expected that additional sites will added.

TABLE 2. Actual and Potential Sites for the Pilot Study of the Georgia Automated Environmental Monitoring Network.

	Actual Sites
Griffin	Georgia Station
Midville	Southeast Georgia Branch Station
Tifton	Coastal Plain Station
	Proposed Sites
Athens	College Station
Attapalgus	Research Farm
Blairsville	Georgia Mountain Branch Station
Calhoun	Northwest Georgia Branch Station
Eatonton	Central Georgia Branch Station
Griffin	Bledsoe Farm
Griffin	Dempsey Farm
Plains	Southwest Georgia Branch Station
Savannah	Coastal Area Research Center
Byron	USDA/ARS-Southeast Fruit and Tree Nut Research Laboratory
Dawson	USDA/ARS-National Peanut Research Laboratory
Watkinsville	USDA/ARS-Southern Piedmont Conservation Research Laboratory

SUMMARY

Based on the 1990 Automated Weather Data Network Workshop and an earlier committee study, it can be concluded that there is a definite need for a Georgia Automated Environmental Monitoring Network (Threadgill, 1990; Westbrook et al., 1988). A pilot AEMN for Georgia has been established, which currently includes three stations, and a centrally located personal computer at the Georgia Station in Griffin for data management and quality control. It is expected that the number of sites will expand in the near future. Programs for weather dissemination and applications are concurrently being developed.

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